PATENT ABSTRACTS OF JAPAN

(11)Publication number : **07-063674**
(43)Date of publication of application : **10.03.1995**

(51)Int.CI. **G01N 21/35**

(21)Application number : **05-235372**
(22)Date of filing : **27.08.1993**

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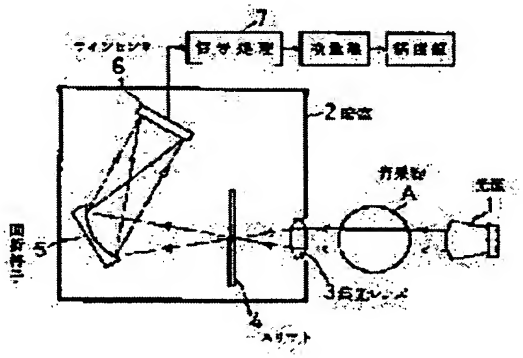
(54) MEASURING METHOD OF SUGAR CONTENT OF VEGETABLES OR FRUITS

(57)Abstract:
PURPOSE: To compensate the temperature of an article such as a vegetable or a fruit and to detect the sugar content of the article with good accuracy by a method wherein the absorbance of a wavelength attributed to the temperature of the article is measured, its measured value is applied to a working curve and the sugar content is calculated.
CONSTITUTION: Near-infrared rays from a light source 1 such as a halogen lamp or the like are transmitted through an article A, and they are subjected to the influence of the properties of the article A, i.e., the component, the temperature, the size and the like of the article A. The transmitted rays which have been subjected to the influence are converged by a condensing lens 3, they are passed through a slit 4, and they are incident on a diffraction grating 5. A flat-field concave-type diffraction grating is used as the diffraction grating 5, the spectrum of all wavelengths is focused on a line sensor 6 without turning the grating 5. The line sensor 6 reads out the absorbance of all the wavelengths in a shortest possible time (about 0.2sec). The absorbance of the wavelength attributed to a sugar content and the temperature of the article out of the read-out absorbance is sent to a signal processing device 7. The device 7 computes its second-order differential value, the value is applied to a sugar-content working curve, and the sugar content is calculated. Thereby, the sugar content can be detected with high accuracy irrespective of the temperature of the article.



LEGAL STATUS

[Date of request for examination]	10.03.1998
[Date of sending the examiner's decision of rejection]	07.03.2000
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	
[Date of registration]	
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

CLAIMS

[Claim(s)]
[Claim 1] The sugar content measuring method of the garden stuff which irradiates a near infrared ray at a device under test, receives the light which penetrated the device under test, measures the absorbance in the wavelength which belongs to the temperature of goods in the sugar content measuring method which measures a sugar content from the absorbance in the wavelength which belongs to sugar, applies the measurement value to a calibration curve, and deduces a sugar content.
[Claim 2] The sugar content measuring method of the garden stuff according to claim 1 which asks for the absorbance in each wavelength which belongs to the temperature of goods of a device under test, sugar, and magnitude, respectively, applies these secondary differential values to the calibration curve of primary joint types, and deduces a sugar content.
[Claim 3] The sugar content measuring method of the garden stuff which irradiates a near infrared ray at a device under test, receives the diffuse reflection light from a device under test, measures the absorbance in the wavelength which belongs to the temperature of goods in the sugar content measuring method which measures a sugar content from the absorbance in the wavelength which belongs to sugar, applies the measurement value to a calibration curve, and deduces a sugar content.
[Claim 4] The sugar content measuring method of the garden stuff according to claim 3 which asks for the absorbance in the wavelength which belongs to the temperature of goods of a device under test, and sugar, respectively, applies these secondary differential values to the calibration curve of primary joint types, and deduces a sugar content.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the approach of measuring a sugar content with high degree of accuracy by having performed temperature compensation especially about the sugar content measuring method for not destroying and measuring the sugar content of garden stuff, such as a mandarin orange and a peach, in an instant.
[0002]
[Description of the Prior Art] The approach of measuring the sugar content of garden stuff by un-destroying is already proposed by this invention person using the transmitted light of a near infrared ray (Japanese Patent Application No. 5-26198). To garden stuff, the outline of this measuring method irradiates a near infrared ray, receives that transmitted light, measures to it the absorbance in the wavelength influenced with sugar, and deduces a sugar content from this measurement value by the operation to it.
[0003]
[Problem(s) to be Solved by the Invention] However, temperature compensation over measured value is not carried out by the aforementioned sugar content measuring method. the spectrum of the near infrared ray which relation with temperature was deep and penetrated garden stuff as infrared radiation was generally also called the heat ray -- if a spectrum is strongly influenced by the temperature of goods and the temperature of goods changes, a measurement absorbance value will change. Therefore, in having deduced the sugar content from this measurement value simply, sugar content measurement with a large error and a high precision cannot be performed. Since that harvesting stage and a shipment term especially change to about 5-30 degrees C of a mandarin orange at a long period of time also in **** and the temperature of goods, the error by this temperature of goods cannot be disregarded.
[0004] In order to cancel this, it is easy in laboratory to arrange the temperature of goods uniformly, although what is necessary is to always fix the temperature of goods of garden stuff, and just to measure it, but in respect of the practical use on industry, it is very difficult, and when targetting the garden stuff under migration for sugar content measurement continuously by conveyor especially, it cannot use.
[0005] This invention uses as an offer plug the measuring method which can always ask for a sugar content with high degree of accuracy regardless of the temperature of goods by performing temperature compensation at the time of measurement in view of such a point.
[0006]
[Means for Solving the Problem] The technical means of the sugar content measuring method of this invention are to irradiate a near infrared ray at a device under test, to receive the light which penetrated the device under test, measure the absorbance in the wavelength which belongs to the

temperature of goods in the sugar content measuring method which measures a sugar content from the absorbance in the wavelength which belongs to sugar, apply the measurement value to a calibration curve, and deduce a sugar content.

[0007] Moreover, it is also possible to replace with the transmitted light and to use the diffuse reflection light from a device under test.

[0008] It asks for the temperature of goods of a device under test, sugar, and the absorbance in each wavelength which belongs to magnitude in the transparent mode, respectively, and you may make it deduce a sugar content for these secondary differential values at the calibration curve of primary joint types.

[0009]

[Function] By the sugar content measuring method of this invention, a near infrared ray (wavelength is 700-1100nm) is irradiated at the garden stuff which is a device under test. Except for that by which an exposure beam of light is absorbed within garden stuff, a part is reflected from garden stuff and others penetrate garden stuff. In addition, after trespassing upon the interior of garden stuff besides the surface reflected light reflected only on the surface of garden stuff to some extent, the diffuse reflection light reflected from the interior is contained in the reflected light.

[0010] Since the transmitted light and diffuse reflection light pass along the interior of garden stuff, they receive the effect by a component, the temperature of goods, etc. of garden stuff in the meantime. Absorption spectrums, such as the component of garden stuff, for example, water, sugar, an acid, a fiber, and protein, differ in wavelength for every component. Therefore, by choosing wavelength, only the thing concerning sugar can be extracted and a sugar content can be deduced after this.

[0011] Moreover, the transmitted light and diffuse reflection light are greatly influenced by the temperature of goods of garden stuff. If for this reason the temperature of goods is disregarded and a sugar content is deduced, precision will fall. The temperature of goods of garden stuff can be deduced from the absorbance of the wavelength which belongs to temperature. Therefore, whenever it asks for the absorbance in the wavelength which belongs to the temperature of goods other than wavelength which belongs to sugar at the time of measurement and applies these to a calibration curve, sugar content measurement with high degree of accuracy can be performed regardless of the temperature of goods. In addition, in the case of the transparent mode, if coincidence is asked for the absorbance in the wavelength which belongs to the magnitude of garden stuff and magnitude is compensated, precision can be raised further. Since it is small, a reflective method may be enough for it, even if the effect by magnitude is disregarded.

[0012]

[Example] The example of the sugar content measuring method of this invention is explained about a drawing. Drawing 1 is the outline of the equipment used at the time of implementation of the sugar content measurement by the transparency type. 1 is the light source and uses that out of which the beam of light containing the wavelength (700-1100nm) of a near infrared region comes, for example, a halogen lamp etc. For a dark room and 3, as for a slit and 5, a condenser lens and 4 are [2 / the diffraction grating of a flat field concave surface mold and 6] line sensors.

[0013] The near infrared ray irradiated from the light source 1 penetrates the garden stuff A which is a measuring object object, and receives the effect by the description of garden stuff in the meantime. Others, the temperature of goods, etc. which are the component matter of the fruit of garden stuff, for example, water, sugar, an acid, a fiber, protein, etc. are contained in this description. however -- each -- the wavelength of the spectrum influenced for every description differs.

[0014] It is completed with a condenser lens 3, and the transmitted light of garden stuff passes along a slit 4, and reaches a diffraction grating 5. The aperture width of a slit 4 affects sensibility and resolution. Usually, considering as 50-200 microns is appropriate. Moreover, without rotating a diffraction grating 5, since a diffraction grating 5 is a flat field concave surface mold, coincidence can be made to be able to tie the spectrum of full wave length for a focus on a line sensor 6, and the

spectrum data (absorbance of 700-1100nm) of full wave length can be read to coincidence with a line sensor 6. Moreover, in the usual case, the above measurement is possible in about 0.2 seconds.
[0015] Data processing of the measurement data in a line sensor 6 is sent and carried out to a signal processor 7. By this operation, the secondary differential value of the spectrum data in several predetermined waves is computed, this is applied to a calibration curve, and a sugar content value is calculated. In addition, the measuring method by the transparent mode explained above is advantageous to especially sugar content measurement of garden stuff with thick hides, such as a mandarin orange.
[0016] Drawing 2 is the outline of the operation equipment at the time of the sugar content measurement by the reflective method. 11 is coaxial glass fiber, a center section is a floodlighting side, and a lateral part is a light-receiving side. A floodlighting side is connected with the light source and the light-receiving side is connected with the detector. A device under test A is set to the upper limit side of glass fiber 11. Reflecting the light which came out of the central floodlighting side a front face and inside garden stuff, the surface reflected light and diffuse reflection light go into a light-receiving side.
[0017] Although both reflected lights are received to coincidence at the time of this light-receiving, the surface reflected light is eliminated in the case of next data processing (secondary differential of spectrum data). In addition, in drawing 2 , 12 is a dark room and 13 is device-under-test supporter material. moreover, the spectrum of the near infrared ray which received light -- processing is performed like the case of drawing 1 . The above reflective method is advantageous to sugar content measurement of garden stuff with thin hides, such as a peach.
[0018] By the way, although it is having become clear by many experiments by this invention person, in the sugar content measurement using the transmitted light and diffuse reflection light of a near infrared ray, specific relation exists between a measurement sugar content and the temperature of goods of garden stuff. Drawing 3 is the graph which made the mandarin orange the measuring object, measured at 20 degrees C of temperature of goods first using the equipment of the transparent mode of drawing 1 , created the calibration curve (several 1) based on the spectrum data, substituted for the calibration curve the data measured by other temperature of goods (10 15 or 25 degrees C), and showed the relation between a measurement sugar content and a true sugar content.
[0019]
[Equation 1]

$$\text{糖度} = 19.323 + 173.1 d^2 \ell o g \left(\frac{1}{R(731)}\right) - 215.356 d^2 \ell o g \left(\frac{1}{R(700)}\right) + 361.106 d^2 \ell o g \left(\frac{1}{R(882)}\right) + 14.969 d^2 \ell o g \left(\frac{1}{R(745)}\right)$$

[0020] Drawing 4 is the graph which made the peach the measuring object and was obtained by the same experiment as the case of the aforementioned transparent mode using the equipment of the reflective method of drawing 2 and which showed the relation between a measurement sugar content and a true sugar content. In addition, several 2 thing is used for the calibration curve here.
[0021]
[Equation 2]

$$糖度 = 11.4 - 630d^2\ell o_g\left(\frac{1}{R(910)}\right) + 2123d^2\ell o_g\left(\frac{1}{R(890)}\right) - 434d^2\ell o_g\left(\frac{1}{R(1012)}\right)$$

[0022] When it asks for a sugar content by the aforementioned method, since the temperature of goods is disregarded, naturally an error comes out between a measurement sugar content value and a true sugar content value, but the error does not come out disorderly, but as shown in drawing 3 or drawing 4 , on the whole, it is shifted up and down. And the amount of bias of this shift can be expressed with the primary type (general formula) of several 3, and when it is a mandarin orange, it can be expressed with the concrete type of several 4.

[0023]

[Equation 3]

$$\Delta B = \alpha + \beta \cdot t$$

ΔB : バイアス量

α , β : 比例定数

t : 品温

[0024]

[Equation 4]

$$\Delta B = -1.62 + 0.107 \cdot t$$

ΔB : バイアス量

t : 品温

[0025] This invention is performing temperature compensation in sugar content measurement using the above fact. That is, sugar content measurement and coincidence are asked for the temperature of goods of garden stuff, and the bias which is equivalent to the sugar content measured value at the temperature of goods is added. A sugar content is computed using the calibration curve which specifically took into consideration the bias which carries out a postscript. And thereby, an always exact sugar content value can be acquired now regardless of the temperature of goods.

[0026] this invention person has already developed the approach of measuring internal temperature, using a near infrared ray as a measuring method of the temperature of goods of garden stuff, and is doing patent application separately. The outline of this measuring method irradiates a near infrared ray at a device under test, receives that transmitted light or diffuse reflection light, asks for the spectrum data in the high wavelength (783, 830, near 899 or 1031nm) of the total correlation with the temperature of goods, and deduces the temperature of goods after this.

[0027] The equipment of drawing 1 or drawing 2 can be used for measurement of this temperature of goods. Therefore, the temperature of goods is measured to sugar content measurement and coincidence, it is the calibration curve which considered bias and the sugar content value which carried out temperature compensation can be deduced at once. In the case of the transparent mode, as this calibration curve, it is good at several 5 linear expression (general formula). Moreover, in the case of a reflective method, since it is not necessary to take the magnitude of a device under test into consideration, the calibration curve which removed the term concerning magnitude is used from

several 5 formula.

[0028]

[Equation 5]

$$\text{糖度} = A_0 + A_1 \cdot d^2R(\lambda_1) + A_2 \cdot d^2R(\lambda_2) + A_3 \cdot d^2R(\lambda_3) + A_4 \cdot d^2R(\lambda_4) + A_5 \cdot d^2R(\lambda_5)$$

$A_0 \sim A_5$: 比例定数

$d^2R(\lambda)$: 波長（λ）でのスペクトルデータの２次微分値

$R(\lambda_1)$: 温度に帰属する波長でのスペクトルデータ

$R(\lambda_2 \sim \lambda_4)$: 糖分に帰属する波長でのスペクトルデータ

$R(\lambda_5)$: 被測定物の大きさに帰属する波長でのスペクトルデータ

[0029] The concrete type of several 6 was used for the calibration curve at the time of carrying out sugar content measurement of the mandarin orange with the transparent mode of drawing 1 . Moreover, when a peach was measured by the reflective method of drawing 2 , several 7 calibration curve was used.

[0030]

[Equation 6]

$$\text{糖度} = 17.467 - 48.746 d^2\ell o g\left(\frac{1}{R(830)}\right) + 184.779 d^2\ell o g\left(\frac{1}{R(731)}\right) - 248.658 d^2\ell o g\left(\frac{1}{R(900)}\right) + 452.046 d^2\ell o g\left(\frac{1}{R(882)}\right) - 4.1 d^2\ell o g\left(\frac{1}{R(745)}\right)$$

[0031]

[Equation 7]

$$\text{糖度} = 14.08 - 1840 d^2\ell o g\left(\frac{1}{R(830)}\right) - 776 d^2\ell o g\left(\frac{1}{R(910)}\right) + 1960 d^2\ell o g\left(\frac{1}{R(890)}\right) - 285 d^2\ell o g\left(\frac{1}{R(1012)}\right)$$

[0032] The result of having computed the sugar content using the aforementioned calibration curve is shown in drawing 5 and drawing 6 . Drawing 5 is the thing of the transparent mode about a mandarin orange, and drawing 6 is the thing of the reflective type about a peach. The error by the temperature of goods is lost and, in any case, the measurement sugar content value is approaching the true sugar

content value in all the temperature of goods. Thereby, it turns out by this invention approach that the sugar content of garden stuff can be correctly measured regardless of the temperature of goods.
[0033] In addition, this invention is not limited to the aforementioned example and deformation implementation is freely possible for it within the limits of the publication of a claim. the detailed structure of especially a measuring device, and a spectrum -- the method of processing, adoption of wavelength, the formula of a calibration curve, etc. are free. Moreover, this invention is available to all garden stuff besides a mandarin orange or a peach.
[0034]
[Effect of the Invention] By the sugar content measuring method of this invention, since the transmitted light of a near infrared ray is used, it can ask for the sugar content of garden stuff by un-destroying. Furthermore, since compensation by the temperature of goods of garden stuff is carried out, sugar content measurement with high degree of accuracy is always possible regardless of the temperature of goods. Moreover, since this invention can be measured in an instant, it can carry out sugar content measurement also of the garden stuff under migration continuously by conveyor, and its practicality is high.
[0035] In the thing of claim 2, data processing is easy, is easy and highly precise, and can acquire a sugar content value.
[0036] In the thing of claim 3, the same sugar content measurement as the aforementioned transparent mode can be performed with a reflective method. Since light income is [method / reflective / transparent mode] large, light-receiving processing is easy. Moreover, this reflective method is suitable to garden stuff with a thin hide.
[0037] In the thing of claim 4, in a reflective method, it is easy and highly precise, and a sugar content value can be calculated.

[Translation done.]

TECHNICAL FIELD

[Industrial Application] This invention relates to the approach of measuring a sugar content with high degree of accuracy by having performed temperature compensation especially about the sugar content measuring method for not destroying and measuring the sugar content of garden stuff, such as a mandarin orange and a peach, in an instant.

[Translation done.]

* NOTICES *

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PRIOR ART

[Description of the Prior Art] The approach of measuring the sugar content of garden stuff by un-destroying is already proposed by this invention person using the transmitted light of a near infrared ray (Japanese Patent Application No. 5-26198). To garden stuff, the outline of this measuring method irradiates a near infrared ray, receives that transmitted light, measures to it the absorbance in the wavelength influenced with sugar, and deduces a sugar content from this measurement value by the operation to it.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] By the sugar content measuring method of this invention, since the transmitted light of a near infrared ray is used, it can ask for the sugar content of garden stuff by un-destroying. Furthermore, since compensation by the temperature of goods of garden stuff is carried out, sugar content measurement with high degree of accuracy is always possible regardless of the temperature of goods. Moreover, since this invention can be measured in an instant, it can carry out sugar content measurement also of the garden stuff under migration continuously by conveyor, and its practicality is high.
[0035] In the thing of claim 2, data processing is easy, is easy and highly precise, and can acquire a sugar content value.
[0036] In the thing of claim 3, the same sugar content measurement as the aforementioned transparent mode can be performed with a reflective method. Since light income is [method / reflective / transparent mode] large, light-receiving processing is easy. Moreover, this reflective method is suitable to garden stuff with a thin hide.
[0037] In the thing of claim 4, in a reflective method, it is easy and highly precise, and a sugar content value can be calculated.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, temperature compensation over measured value is not carried out by the aforementioned sugar content measuring method. the spectrum of the near infrared ray which relation with temperature was deep and penetrated garden stuff as infrared radiation was generally also called the heat ray -- if a spectrum is strongly influenced by the temperature of goods and the temperature of goods changes, a measurement absorbance value will change. Therefore, in having deduced the sugar content from this measurement value simply, sugar content measurement with a large error and a high precision cannot be performed. Since that harvesting stage and a shipment term especially change to about 5-30 degrees C of a mandarin orange at a long period of time also in **** and the temperature of goods, the error by this temperature of goods cannot be disregarded.
[0004] In order to cancel this, it is easy in laboratory to arrange the temperature of goods uniformly, although what is necessary is to always fix the temperature of goods of garden stuff, and just to measure it, but in respect of the practical use on industry, it is very difficult, and when targetting the garden stuff under migration for sugar content measurement continuously by conveyor especially, it cannot use.
[0005] This invention uses as an offer plug the measuring method which can always ask for a sugar content with high degree of accuracy regardless of the temperature of goods by performing temperature compensation at the time of measurement in view of such a point.

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MEANS

[Means for Solving the Problem] The technical means of the sugar content measuring method of this invention are to irradiate a near infrared ray at a device under test, to receive the light which penetrated the device under test, measure the absorbance in the wavelength which belongs to the temperature of goods in the sugar content measuring method which measures a sugar content from the absorbance in the wavelength which belongs to sugar, apply the measurement value to a calibration curve, and deduce a sugar content.
[0007] Moreover, it is also possible to replace with the transmitted light and to use the diffuse reflection light from a device under test.
[0008] It asks for the temperature of goods of a device under test, sugar, and the absorbance in each wavelength which belongs to magnitude in the transparent mode, respectively, and you may make it deduce a sugar content for these secondary differential values at the calibration curve of primary joint types.

[Translation done.]

OPERATION

[Function] By the sugar content measuring method of this invention, a near infrared ray (wavelength is 700-1100nm) is irradiated at the garden stuff which is a device under test. Except for that by which an exposure beam of light is absorbed within garden stuff, a part is reflected from garden stuff and others penetrate garden stuff. In addition, after trespassing upon the interior of garden stuff besides the surface reflected light reflected only on the surface of garden stuff to some extent, the diffuse reflection light reflected from the interior is contained in the reflected light.
[0010] Since the transmitted light and diffuse reflection light pass along the interior of garden stuff, they receive the effect by a component, the temperature of goods, etc. of garden stuff in the meantime. Absorption spectrums, such as the component of garden stuff, for example, water, sugar, an acid, a fiber, and protein, differ in wavelength for every component. Therefore, by choosing wavelength, only the thing concerning sugar can be extracted and a sugar content can be deduced after this.
[0011] Moreover, the transmitted light and diffuse reflection light are greatly influenced by the temperature of goods of garden stuff. If for this reason the temperature of goods is disregarded and a sugar content is deduced, precision will fall. The temperature of goods of garden stuff can be deduced from the absorbance of the wavelength which belongs to temperature. Therefore, whenever it asks for the absorbance in the wavelength which belongs to the temperature of goods other than wavelength which belongs to sugar at the time of measurement and applies these to a calibration curve, sugar content measurement with high degree of accuracy can be performed regardless of the temperature of goods. In addition, in the case of the transparent mode, if coincidence is asked for the absorbance in the wavelength which belongs to the magnitude of garden stuff and magnitude is compensated, precision can be raised further. Since it is small, a reflective method may be enough for it, even if the effect by magnitude is disregarded.

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EXAMPLE

[Example] The example of the sugar content measuring method of this invention is explained about a drawing. Drawing 1 is the outline of the equipment used at the time of implementation of the sugar content measurement by the transparency type. 1 is the light source and uses that out of which the beam of light containing the wavelength (700-1100nm) of a near infrared region comes, for example, a halogen lamp etc. For a dark room and 3, as for a slit and 5, a condenser lens and 4 are [2 / the diffraction grating of a flat field concave surface mold and 6] line sensors.
[0013] The near infrared ray irradiated from the light source 1 penetrates the garden stuff A which is a measuring object object, and receives the effect by the description of garden stuff in the meantime. Others, the temperature of goods, etc. which are the component matter of the fruit of garden stuff, for example, water, sugar, an acid, a fiber, protein, etc. are contained in this description. however -- each -- the wavelength of the spectrum influenced for every description differs.
[0014] It is completed with a condenser lens 3, and the transmitted light of garden stuff passes along a slit 4, and reaches a diffraction grating 5. The aperture width of a slit 4 affects sensibility and resolution. Usually, considering as 50-200 microns is appropriate. Moreover, without rotating a diffraction grating 5, since a diffraction grating 5 is a flat field concave surface mold, coincidence can be made to be able to tie the spectrum of full wave length for a focus on a line sensor 6, and the spectrum data (absorbance of 700-1100nm) of full wave length can be read to coincidence with a line sensor 6. Moreover, in the usual case, the above measurement is possible in about 0.2 seconds.
[0015] Data processing of the measurement data in a line sensor 6 is sent and carried out to a signal processor 7. By this operation, the secondary differential value of the spectrum data in several predetermined waves is computed, this is applied to a calibration curve, and a sugar content value is calculated. In addition, the measuring method by the transparent mode explained above is advantageous to especially sugar content measurement of garden stuff with thick hides, such as a mandarin orange.
[0016] Drawing 2 is the outline of the operation equipment at the time of the sugar content measurement by the reflective method. 11 is coaxial glass fiber, a center section is a floodlighting side, and a lateral part is a light-receiving side. A floodlighting side is connected with the light source and the light-receiving side is connected with the detector. A device under test A is set to the upper limit side of glass fiber 11. Reflecting the light which came out of the central floodlighting side a front face and inside garden stuff, the surface reflected light and diffuse reflection light go into a light-receiving side.
[0017] Although both reflected lights are received to coincidence at the time of this light-receiving, the surface reflected light is eliminated in the case of next data processing (secondary differential of spectrum data). In addition, in drawing 2 , 12 is a dark room and 13 is device-under-test supporter material. moreover, the spectrum of the near infrared ray which received light -- processing is performed like the case of drawing 1 . The above reflective method is advantageous to sugar content

measurement of garden stuff with thin hides, such as a peach.
[0018] By the way, although it is having become clear by many experiments by this invention person, in the sugar content measurement using the transmitted light and diffuse reflection light of a near infrared ray, specific relation exists between a measurement sugar content and the temperature of goods of garden stuff. Drawing 3 is the graph which made the mandarin orange the measuring object, measured at 20 degrees C of temperature of goods first using the equipment of the transparent mode of drawing 1 , created the calibration curve (several 1) based on the spectrum data, substituted for the calibration curve the data measured by other temperature of goods (10 15 or 25 degrees C), and showed the relation between a measurement sugar content and a true sugar content.
[0019]
[Equation 1]

$$\text{糖度} = 19.323 + 173.1 d^2 \ell o g \left(\frac{1}{R(731)}\right) - 215.356 d^2 \ell o g \left(\frac{1}{R(700)}\right) + 361.106 d^2 \ell o g \left(\frac{1}{R(882)}\right) + 14.969 d^2 \ell o g \left(\frac{1}{R(745)}\right)$$

[0020] Drawing 4 is the graph which made the peach the measuring object and was obtained by the same experiment as the case of the aforementioned transparent mode using the equipment of the reflective method of drawing 2 and which showed the relation between a measurement sugar content and a true sugar content. In addition, several 2 thing is used for the calibration curve here.
[0021]
[Equation 2]

$$\text{糖度} = 11.4 - 630 d^2 \ell o g \left(\frac{1}{R(910)}\right) + 2123 d^2 \ell o g \left(\frac{1}{R(890)}\right) - 434 d^2 \ell o g \left(\frac{1}{R(1012)}\right)$$

[0022] When it asks for a sugar content by the aforementioned method, since the temperature of goods is disregarded, naturally an error comes out between a measurement sugar content value and a true sugar content value, but the error does not come out disorderly, but as shown in drawing 3 or drawing 4 , on the whole, it is shifted up and down. And the amount of bias of this shift can be expressed with the primary type (general formula) of several 3, and when it is a mandarin orange, it can be expressed with the concrete type of several 4.
[0023]
[Equation 3]

$$\Delta B = \alpha + \beta \cdot t$$

ΔB : バイアス量

α , β : 比例定数

t : 品温

[0024]

[Equation 4]
$\Delta B = -1.62 + 0.107 \cdot t$

ΔB : バイアス量

t : 品温

[0025] This invention is performing temperature compensation in sugar content measurement using the above fact. That is, sugar content measurement and coincidence are asked for the temperature of goods of garden stuff, and the bias which is equivalent to the sugar content measured value at the temperature of goods is added. A sugar content is computed using the calibration curve which specifically took into consideration the bias which carries out a postscript. And thereby, an always exact sugar content value can be acquired now regardless of the temperature of goods.
[0026] this invention person has already developed the approach of measuring internal temperature, using a near infrared ray as a measuring method of the temperature of goods of garden stuff, and is doing patent application separately. The outline of this measuring method irradiates a near infrared ray at a device under test, receives that transmitted light or diffuse reflection light, asks for the spectrum data in the high wavelength (783, 830, near 899 or 1031nm) of the total correlation with the temperature of goods, and deduces the temperature of goods after this.
[0027] The equipment of drawing 1 or drawing 2 can be used for measurement of this temperature of goods. Therefore, the temperature of goods is measured to sugar content measurement and coincidence, it is the calibration curve which considered bias and the sugar content value which carried out temperature compensation can be deduced at once. In the case of the transparent mode, as this calibration curve, it is good at several 5 linear expression (general formula). Moreover, in the case of a reflective method, since it is not necessary to take the magnitude of a device under test into consideration, the calibration curve which removed the term concerning magnitude is used from several 5 formula.
[0028]
[Equation 5]
$$\text{糖度} = A_0 + A_1 \cdot d^2R(\lambda_1) + A_2 \cdot d^2R(\lambda_2) + A_3 \cdot d^2R(\lambda_3) + A_4 \cdot d^2R(\lambda_4) + A_5 \cdot d^2R(\lambda_5)$$

$A_0 \sim A_5$: 比例定数

$d^2R(\lambda)$: 波長（λ）でのスペクトルデータの２次微分値

$R(\lambda_1)$: 温度に帰属する波長でのスペクトルデータ

$R(\lambda_2 \sim \lambda_4)$: 糖分に帰属する波長でのスペクトルデータ

$R(\lambda_5)$: 被測定物の大きさに帰属する波長でのスペクトルデータ

[0029] The concrete type of several 6 was used for the calibration curve at the time of carrying out

sugar content measurement of the mandarin orange with the transparent mode of drawing 1 . Moreover, when a peach was measured by the reflective method of drawing 2 , several 7 calibration curve was used.

[0030]

[Equation 6]

$$\text{糖度} = 17.467 - 48.746 d^2 \ell o g \left(\frac{1}{R(830)}\right) + 184.779 d^2 \ell o g \left(\frac{1}{R(731)}\right) - 248.658 d^2 \ell o g \left(\frac{1}{R(900)}\right) + 452.046 d^2 \ell o g \left(\frac{1}{R(882)}\right) - 4.1 d^2 \ell o g \left(\frac{1}{R(745)}\right)$$

[0031]

[Equation 7]

$$\text{糖度} = 14.08 - 1840 d^2 \ell o g \left(\frac{1}{R(830)}\right) - 776 d^2 \ell o g \left(\frac{1}{R(910)}\right) + 1960 d^2 \ell o g \left(\frac{1}{R(890)}\right) - 285 d^2 \ell o g \left(\frac{1}{R(1012)}\right)$$

[0032] The result of having computed the sugar content using the aforementioned calibration curve is shown in drawing 5 and drawing 6 . Drawing 5 is the thing of the transparent mode about a mandarin orange, and drawing 6 is the thing of the reflective type about a peach. The error by the temperature of goods is lost and, in any case, the measurement sugar content value is approaching the true sugar content value in all the temperature of goods. Thereby, it turns out by this invention approach that the sugar content of garden stuff can be correctly measured regardless of the temperature of goods.

[0033] In addition, this invention is not limited to the aforementioned example and deformation implementation is freely possible for it within the limits of the publication of a claim. the detailed structure of especially a measuring device, and a spectrum -- the method of processing, adoption of wavelength, the formula of a calibration curve, etc. are free. Moreover, this invention is available to all garden stuff besides a mandarin orange or a peach.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

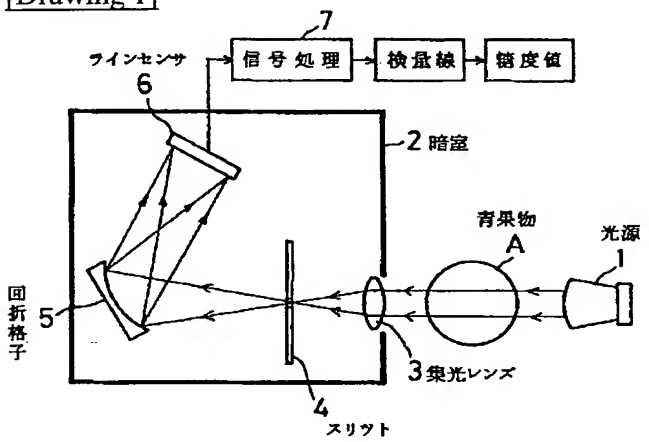
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Drawing showing the outline of the absorbance measuring device of a near infrared ray in the transparent mode.
[Drawing 2] The sectional view of the exposure and light sensing portion of a near infrared ray in a reflective method.
[Drawing 3] The graph of the measurement sugar content of temperature-of-goods disregard with a mandarin orange.
[Drawing 4] The graph of the measurement sugar content of temperature-of-goods disregard with a peach.
[Drawing 5] The graph of a measurement sugar content [finishing / the temperature compensation in a mandarin orange].
[Drawing 6] The graph of a measurement sugar content [finishing / the temperature compensation in a peach].
[Description of Notations]
1 Light Source
2 Condenser Lens
5 Diffraction Grating of Concave Surface Mold
6 Line Sensor
7 Signal Processor
11 Glass Fiber
12 Dark Room

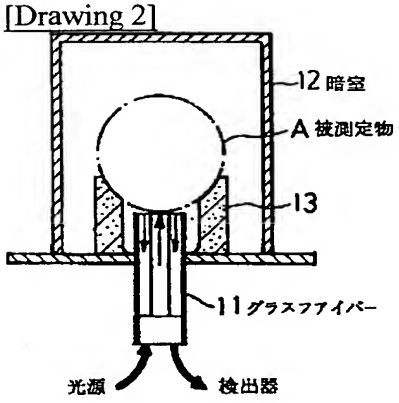
[Translation done.]

DRAWINGS

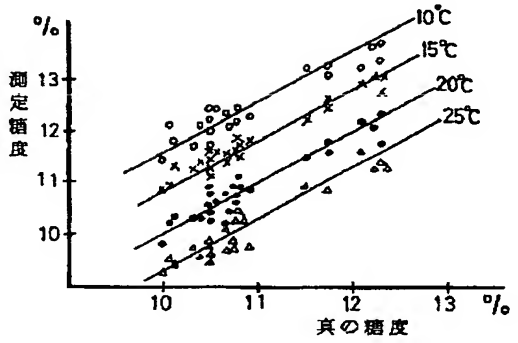
[Drawing 1]



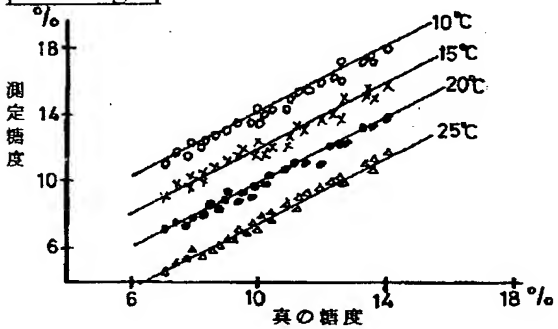
[Drawing 2]



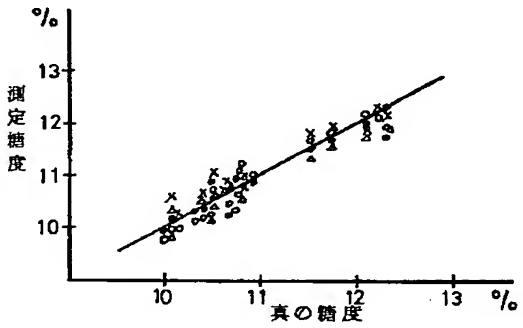
[Drawing 3]



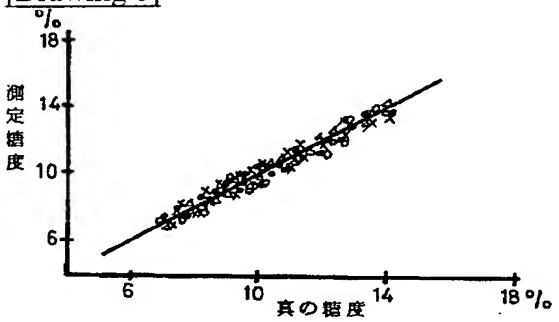
[Drawing 4]



[Drawing 5]



[Drawing 6]



[Translation done.]

MEASURING METHOD OF SUGAR CONTENT OF VEGETABLES OR FRUITS

Patent number: JP7063674

Publication date: 1995-03-10

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Classification:

- international: ***G01N21/35;*** **G01N21/31;** (IPC1-7): G01N21/35

- european:

Application number: JP19930235372 19930827

Priority number(s): JP19930235372 19930827

Abstract of **JP7063674**

PURPOSE:To compensate the temperature of an article such as a vegetable or a fruit and to detect the sugar content of the article with good accuracy by a method wherein the absorbance of a wavelength attributed to the temperature of the article is measured, its measured value is applied to a working curve and the sugar content is calculated.

CONSTITUTION:Near-infrared rays from a light source 1 such as a halogen lamp or the like are transmitted through an article A, and they are subjected to the influence of the properties of the article A, i.e., the component, the temperature, the size and the like of the article A. The transmitted rays which have been subjected to the influence are converged by a condensing lens 3, they are passed through a slit 4, and they are incident on a diffraction grating 5. A flat-field concave-type diffraction grating is used as the diffraction grating 5, the spectrum of all wavelengths is focused on a line sensor 6 without turning the grating 5. The line sensor 6 reads out the absorbance of all the wavelengths in a shortest possible time (about 0.2sec). The absorbance of the wavelength attributed to a sugar content and the temperature of the article out of the read-out absorbance is sent to a signal processing device 7. The device 7 computes its second-order differential value, the value is applied to a sugar-content working curve, and the sugar content is calculated. Thereby, the sugar content can be detected with high accuracy irrespective of the temperature of the article.